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PHYTOTOXICOLOGY INVESTIGATION IN THE VICINITY OF THE ITT-AIMCO FOUNDRY, ST. CATHARINES, 1991

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PHYTOXICOLOGY INVESTIGATION IN THE VICINITY OF THE ITT-AIMCO FOUNDRY, ST. CATHARINES, 1991

Report prepared by:

Marius March
Phytotoxicology Section
Standards Development Branch

Abstract

Phytotoxicology Investigation in the Vicinity of the ITT-Aimco Foundry, St. Catharines. 1991.

On September 5 1991 the Phytotoxicology Section collected tree foliage in the vicinity of the ITT-Aimco foundry in St. Catharines. Foliar fluoride and manganese concentrations near the foundry exceeded the urban ULN guidelines. Foliar iron and lead concentrations also were above local background concentrations, but they did not exceed ULN guidelines.

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Phytotoxicology Investigation In the Vicinity of the ITT -Aimco Foundry St. Catharines, 1991

Introduction

In the spring of 1991, the Welland District Office of the Ontario Ministry of the Environment requested the Phytotoxicology Section to conduct an assessment survey around the ITT - Aimco foundry in St. Catharines. There have been numerous complaints from nearby residents regarding particulate emissions from the plant.

The Aimco plant is a ferrous foundry that produces about 23,000 tons of automotive castings per year from scrap metal, iron, coke, limestone, and scrap castings. Abatement equipment at the plant includes three natural gas afterburners for incineration of hydrocarbons and uncombusted emissions from the cupola, and a baghouse for capturing particulates. Access to the materials storage areas had been by an unpaved road and turning areas that ran adjacent to residential properties; however, most of these areas were paved in May to August of 1991.

During 1991, the West Central Region conducted a high volume air sampling (Hivol) survey near Aimco with one sampler located about 100 m west of Aimco and another 100 m east of the foundry. The survey was conducted during the period in which Aimco was instituting an abatement program. The results indicated that Aimco was the main source of particulate emissions on Plymouth Avenue. The emissions were largely a result of fugitive dust sources and were noticeably reduced by the abatement activities that occurred during the monitoring. Since concentrations of most metals were found to be near background, the Hivol study had focused on total suspended particulates, iron, manganese, and carbon.

Field Inspection

On September 5 of 1991 Marius Marsh and Chengyong Zhang of the Phytotoxicology Section conducted an investigation of Silver maple (Acer saccharinium) and Manitoba maple (Acer negundo) foliage in the vicinity of the Aimco foundry. Foliage samples were collected in triplicate from twelve stations in the vicinity of the foundry (see Figure 1) as well as from a location about 1200 m to the south , which served as a control site. All samples were collected using standard Phytotoxicology sampling techniques. Samples were delivered to the Phytotoxicology Section sample processing laboratory in Toronto where they were dried and ground before being submitted to the Laboratory Services Branch Trace Inorganics Laboratory for chemical analysis. Samples were analyzed for lead, iron, manganese, aluminum, arsenic, cadmium, fluoride, molybdenum, antimony, sulphur, and vanadium. In addition, two samples from the sites nearest the foundry were analyzed for cyanide.

During the collection of samples, light injury was observed on Manitoba maple foliage at Station 2. The injury consisted of tip and marginal necrosis indicative of a fluoride type injury, as well as epinastic growth on newer shoots. Similar injuries were not noted at other sites. In addition, bifacial necrotic spotting was observed on Manitoba maple at Station 1. This injury was attributable to mites.

Results and Discussion

The analytical results for foliar concentrations of lead, iron, manganese, aluminum, fluoride, molybdenum and sulphur are presented below. The results for arsenic, cadmium, antimony and vanadium are not presented since concentrations of these elements were not present above trace amounts in any of the samples. Concentrations of cyanide in the two samples from immediately adjacent to the foundry were at or below trace levels, hence further analysis for cyanide was not conducted.

Elemental Concentrations (ug/g, mean of 3 samples) in Tree Foliage in the Vicinity of Aimco Foundry, St. Catharines, September 5, 1991.

Site	Species	Lead	Iron	Manganese	Aluminum	Fluoride	Molybdenum	Sulphur (%)
1	M	2.1	460	37	134	31	0.63	0.22
2	M	3.2	380	96	117	9.5	0.7	0.26
3	S	4.9	513	**213**	230	12	0.3	0.22
4	M	1.2	183	40	64	8.1	0.23	0.2
5	S	2.1	373	41	187	11	0.2	0.13
6	M	0.8	102	26	34	4.2	0.4	0.15
6	S	2.3	157	23	80	5.1	0.2	0.17
7	M	3.9	383	29	107	9.1	0.23	0.27
8	M	0.9	196	18	111	5.6	0.3	0.19
9	S	2.8	240	24	137	10	0.23	0.16
10 (control)	M	0.8	147	50	76	4.2	0.33	0.17
10 (control)	S	1.4	167	30	94	4.6	0.23	0.13
11	S	2.6	260	33	103	14	0.23	0.26
12	S	6.3	447	**102**	150	**39**	0.33	0.19
12	M	6.8	610	70	157	**39**	0.5	0.18
13	S	1.6	247	41	150	9.1	0.2	0.19
ULN*		60	1000	100	500	35	1.5	0.4

M - Manitoba maple
S - Silver maple
* - ULN = Upper Limit of Normal for urban foliage. See Appendix
- Analyses for Sulphur were on single or duplicate samples only
- Values shown in bold and underlined exceed the ULN guideline

Contour maps of foliar elemental concentrations were drawn in order to estimate probable spacial distribution of these elements for interpretive purposes. A computer mapping software package (Surfer, version 4) was used. Settings used in "Surfer" were as follows: Kriging using normal search method on ten nearest points, 20 meter grid in both x and y directions and smoothing with a tension factor of two. The resultant contour maps are shown in Figures 2 - 8. Care should be taken in interpretation of these maps since actual concentrations are known only at the sampling locations.

The only elements for which the urban ULN is exceeded are manganese at Sites 3 and 12, and fluoride at Site 12. The contour map for manganese (Fig 2) does not indicate that Aimco is the main source of manganese. Since the prevailing winds in this area are strongly from the west, the more likely source of the manganese is a foundry to the west. In a previous Phytotoxicology Section report (MOE Report # ARB-066-90-PHYTO), the Cunningham Foundry was implicated as a likely source of elevated manganese, iron, and fluoride. In spite of abatement activities at Cunningham, the manganese concentrations in foliage at Site 3 have actually increased since the 1989 survey. If there has been any degree of success of these abatement activities there should have been a decline in manganese concentrations, as there was for iron, at Site 1. This may be indicating that the main source of manganese is actually the ALCAN foundry to the west, and that Aimco is contributing only marginally to the elevated concentrations. Manganese is used in some aluminum products, such as aluminum cans, to add strength. In this regard, it should also be noted that the contour map pattern for manganese is similar to that for aluminum (Fig 3) in that Site 1 appears to be shadowed by the Cunningham building.

Figure 4 indicates that elevated foliar fluoride concentrations are resulting from activities at Aimco. The increases are such that fluoride concentrations are above the urban ULN of 35 ug/g at Site 12, immediately adjacent to the foundry. Figure 4 indicates that the zone of elevated fluoride concentrations is restricted to within about 200 m downwind of the foundry. An additional zone of elevated foliar fluoride concentrations is evident in the immediate vicinity of the Cunningham foundry. This zone does not extend more than about 100 m from the Cunningham foundry, and concentrations within it do not reach the urban ULN.

Figure 5 indicates generally elevated foliar concentrations of iron in the vicinity of this industrial area that includes the Aimco, Cunningham, and Foster Wheeler foundries. There are clear peaks in concentrations immediately downwind from both Aimco and Cunningham. Since there were no suitable sampling sites immediately downwind from Foster Wheeler, a similar distinct pattern is not evident, even though there is a noticeable bending of the contour lines around that foundry. In no case do foliar concentrations exceed the urban ULN, although concentrations downwind from both Aimco (reaching 610 ug/g) and Cunningham (reaching 513 ug/g) are clearly elevated above local background concentrations as represented at Site 10 (157 ug/g), as well as at Site 6 (167 ug/g), which is upwind from the foundries.

Contour maps of foliar lead and molybdenum concentrations are shown in Figure 6 and Figure 7 respectively. A clear pattern of elevated concentrations near both Aimco and Cunningham is evident; however, lead concentrations are consistently below the urban ULN of 60 ug/g, and molybdenum concentrations are less than half of the ULN of 1.4 ug/g. Although the mapping implicates these foundries as sources of these two elements, the significance is marginal in relation to the terrestrial environment. Similarly, the mapping indicates foliar sulphur concentrations to be slightly elevated in the immediate vicinity of these foundries (Figure 8); however, the magnitude of these concentrations is of marginal environmental significance.

Conclusions

Analysis of foliar samples in the vicinity of the Aimco foundry indicate that Aimco is a likely source of fluoride emissions. Maple foliage in the immediate vicinity of the foundry exhibited concentrations in excess of the urban ULN for fluoride. Although foliar manganese concentrations immediately downwind of Aimco exceeded the relevant ULN, contour mapping indicates that most of the manganese is likely originating from a source to the west of Aimco, and Aimco is only contributing marginally to an already elevated background concentration. Contour mapping also indicates that Aimco is a likely source of iron and lead, although the foliar concentrations of these two elements do not exceed the expected upper limits of urban background concentrations in Ontario.

Abatement activities at the Aimco foundry likely reduced the fugitive emissions of many elements throughout the summer of 1991. These reductions may already have been evident in the foliar elemental concentrations determined in this survey, although, since foliar elemental concentrations result from accumulations throughout the growing season, this survey will not reflect the full effect of the abatement activities that were implemented during the growing season. The type of abatement activities carried out in 1991, such as paving of roads and parking areas, road oiling, and landscaping, is unlikely to have affected fluoride emissions significantly.

Figure 1: Location of Foliar Sampling Sites, AIMCO Foundry, St. Catharines, Sept. 5, 1991

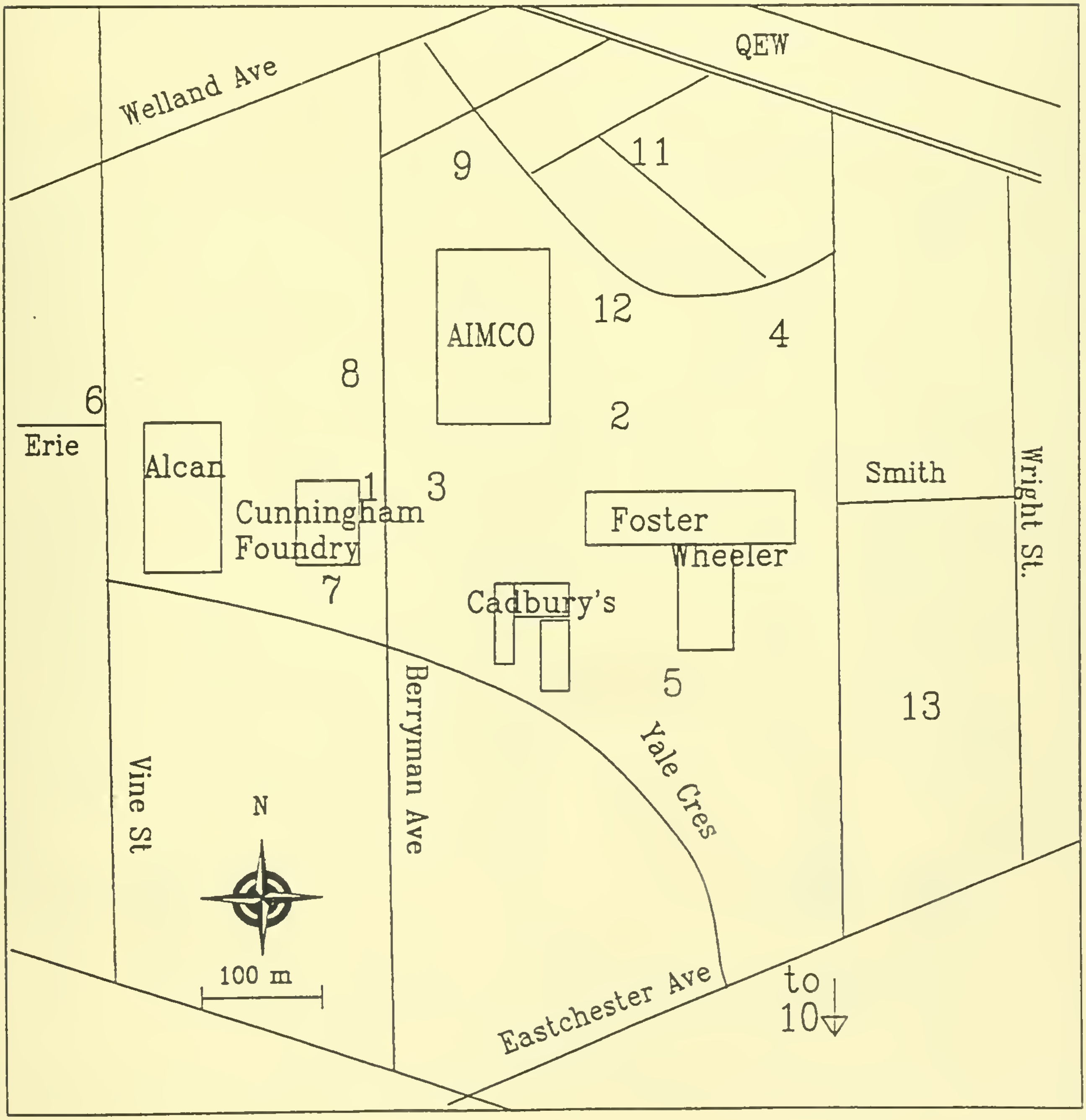


Figure 2: Contour Map of Foliar Manganese Concentrations (ug/g) in the Vicinity of the Aimco Foundry, St. Catharines, 1991.

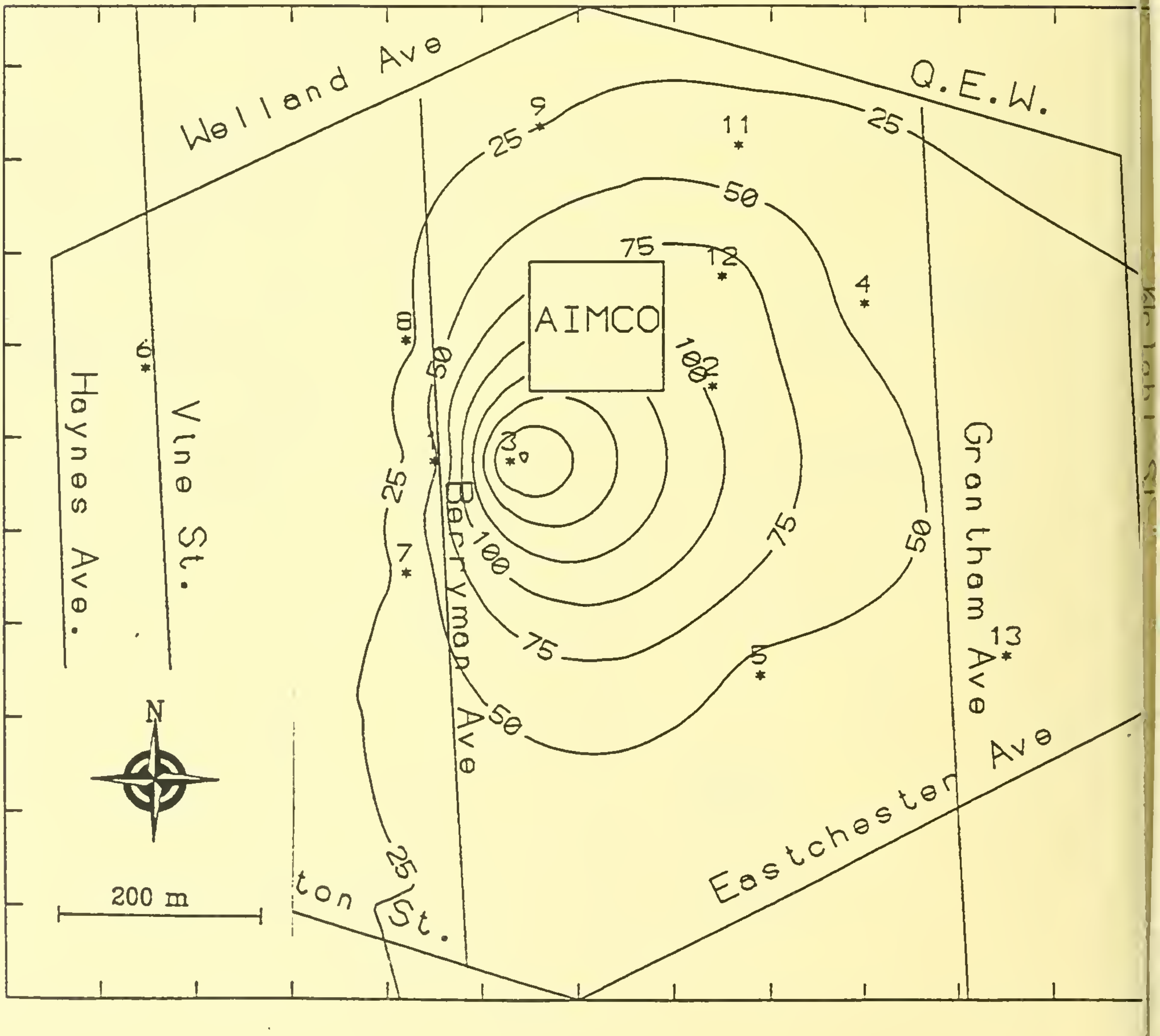


Figure 3: Contour Map of Foliar Aluminum Concentrations (ug/g) in the Vicinity of the Aimco Foundry, St. Catharines, 1991.

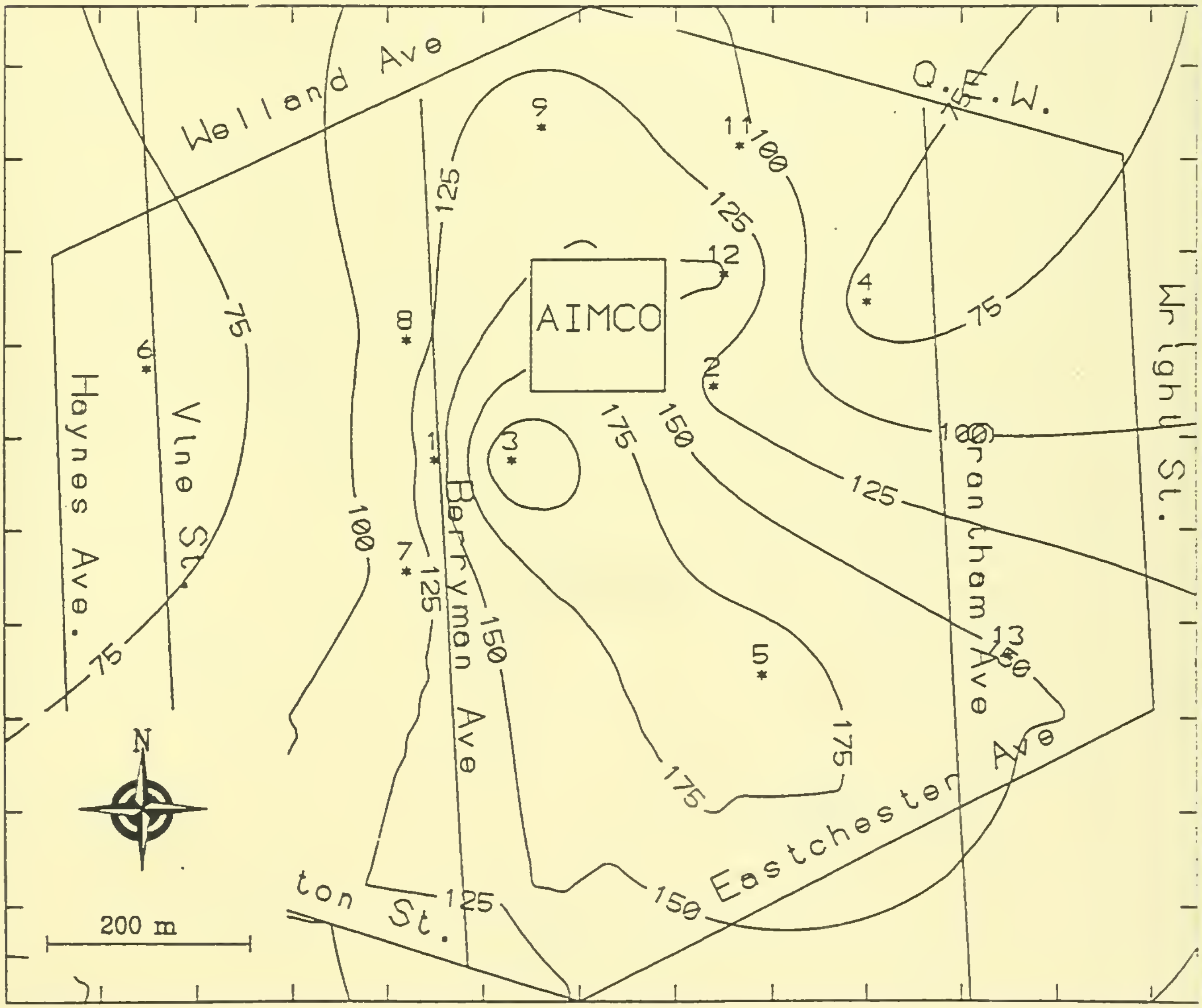


Figure 4: Contour Map of Foliar Fluoride Concentrations (ug/g) in the Vicinity of the Aimco Foundry, St. Catharines, 1991.

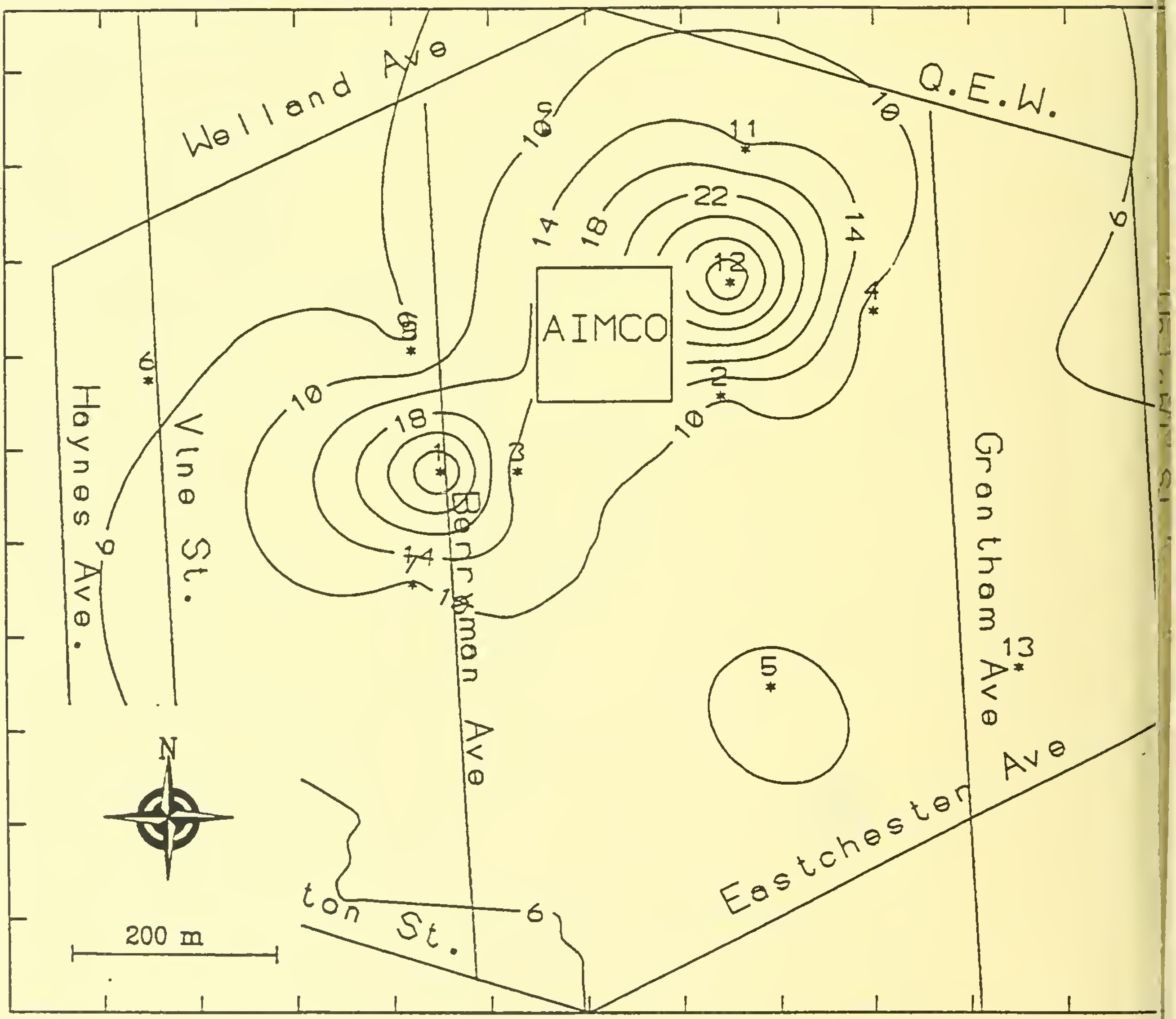


Figure 5: Contour Map of Foliar Iron Concentrations (ug/g) in the Vicinity of the Aimco Foundry, St. Catharines, 1991.

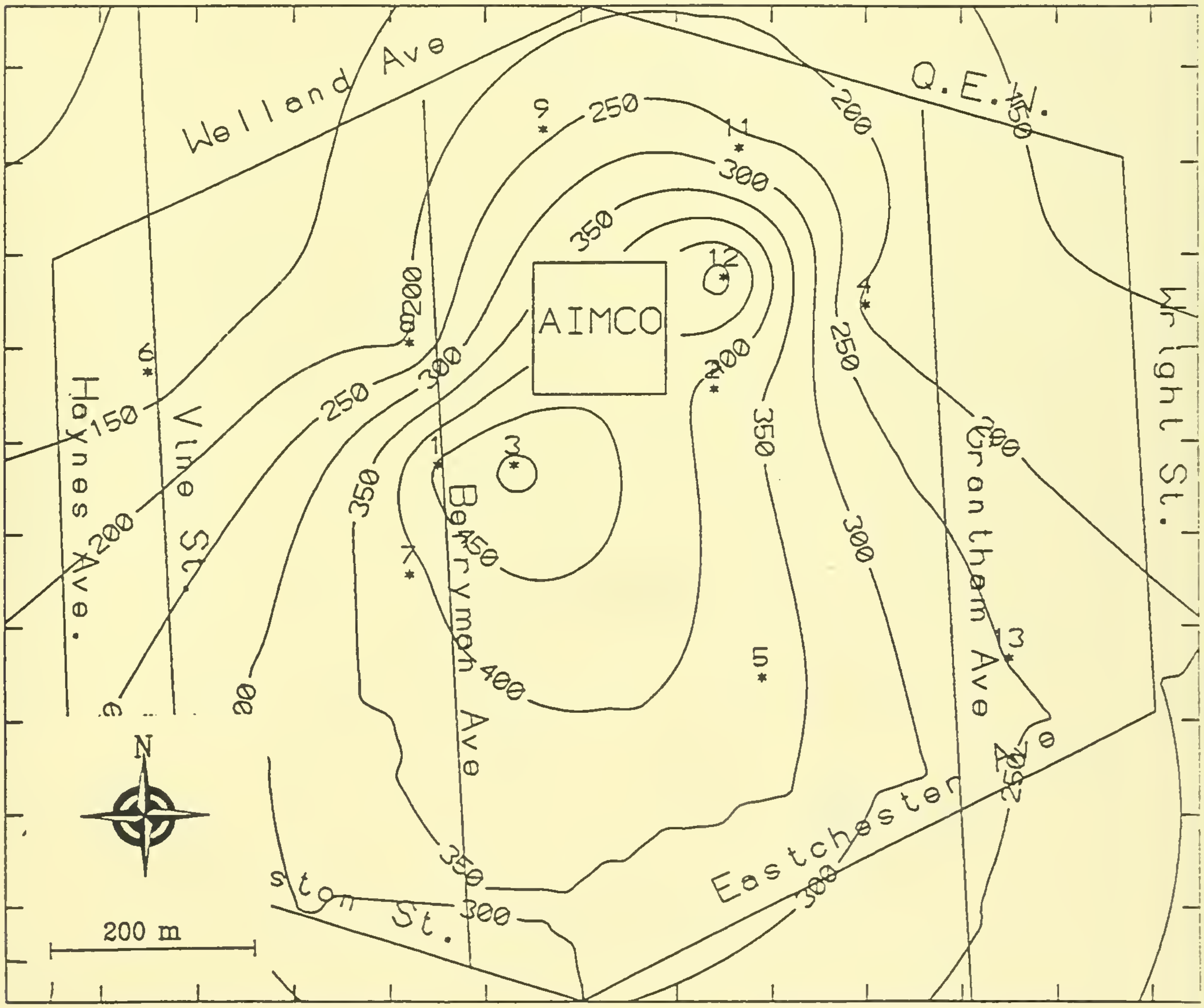


Figure 6: Contour Map of Foliar Lead Concentrations (ug/g) in the Vicinity of the Aimco Foundry, St. Catharines, 1991.

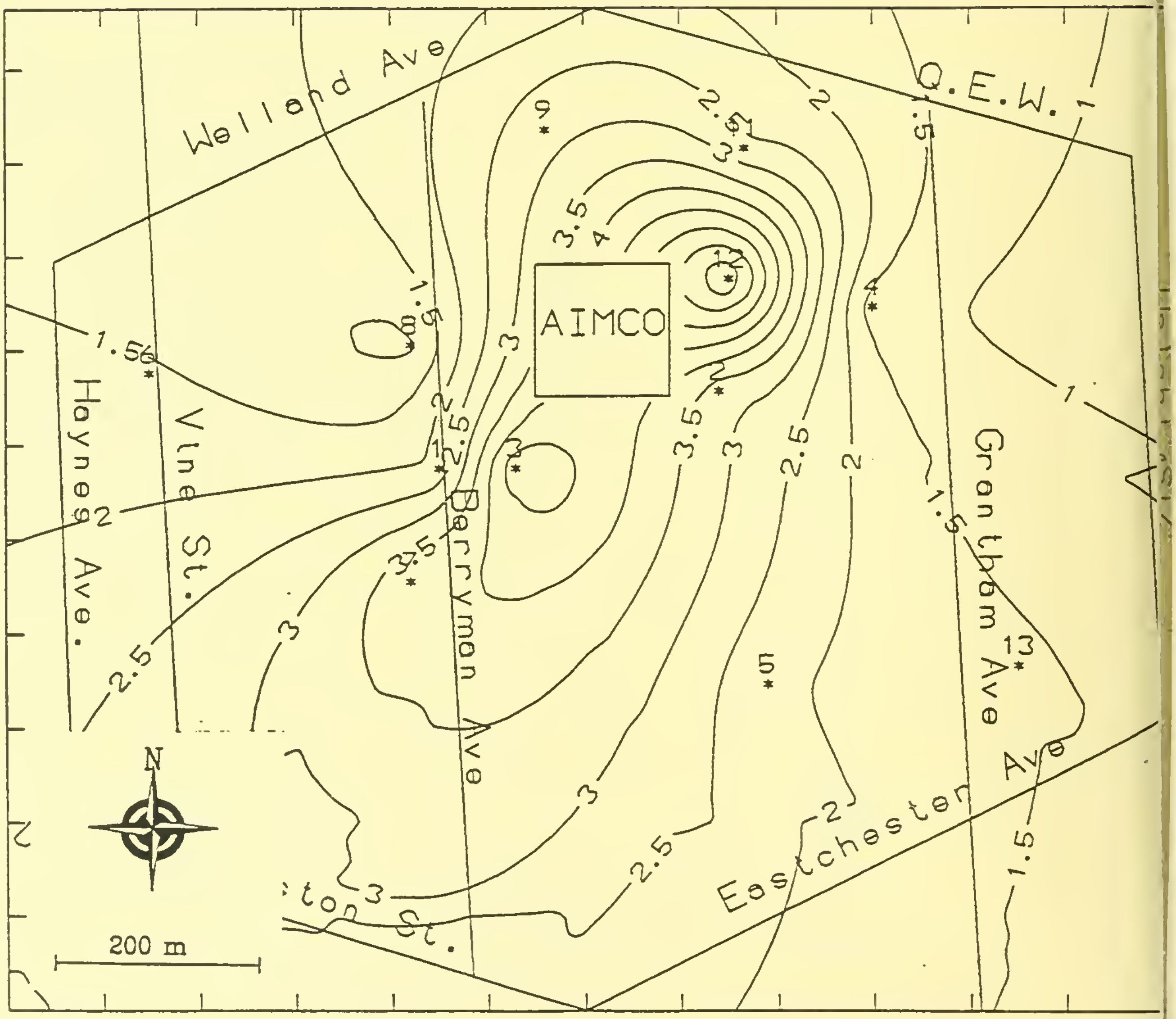


Figure 7: Contour Map of Foliar Molybdenum Concentrations (ug/g) in the Vicinity of the Aimco Foundry, St. Catharines, 1991.

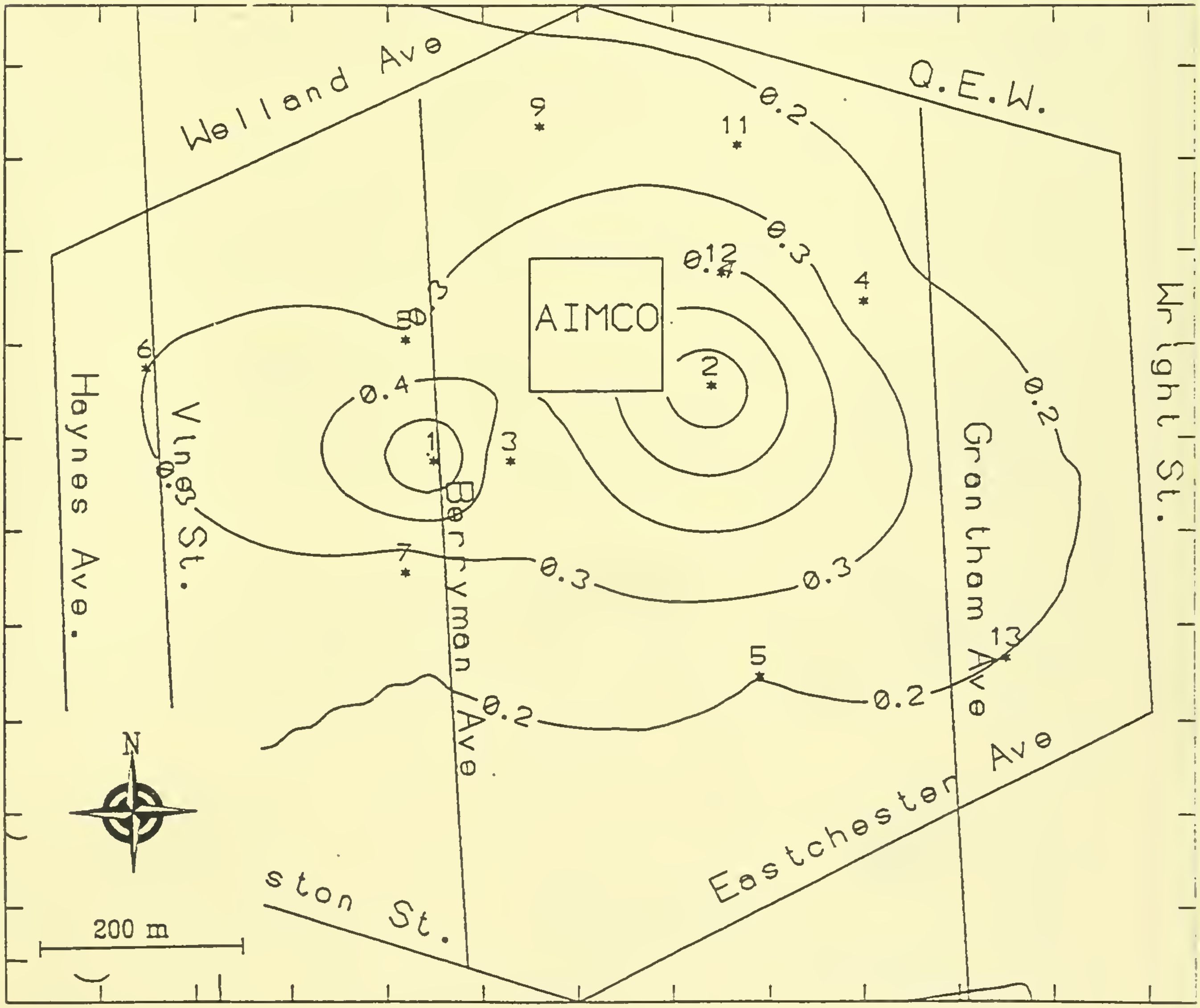
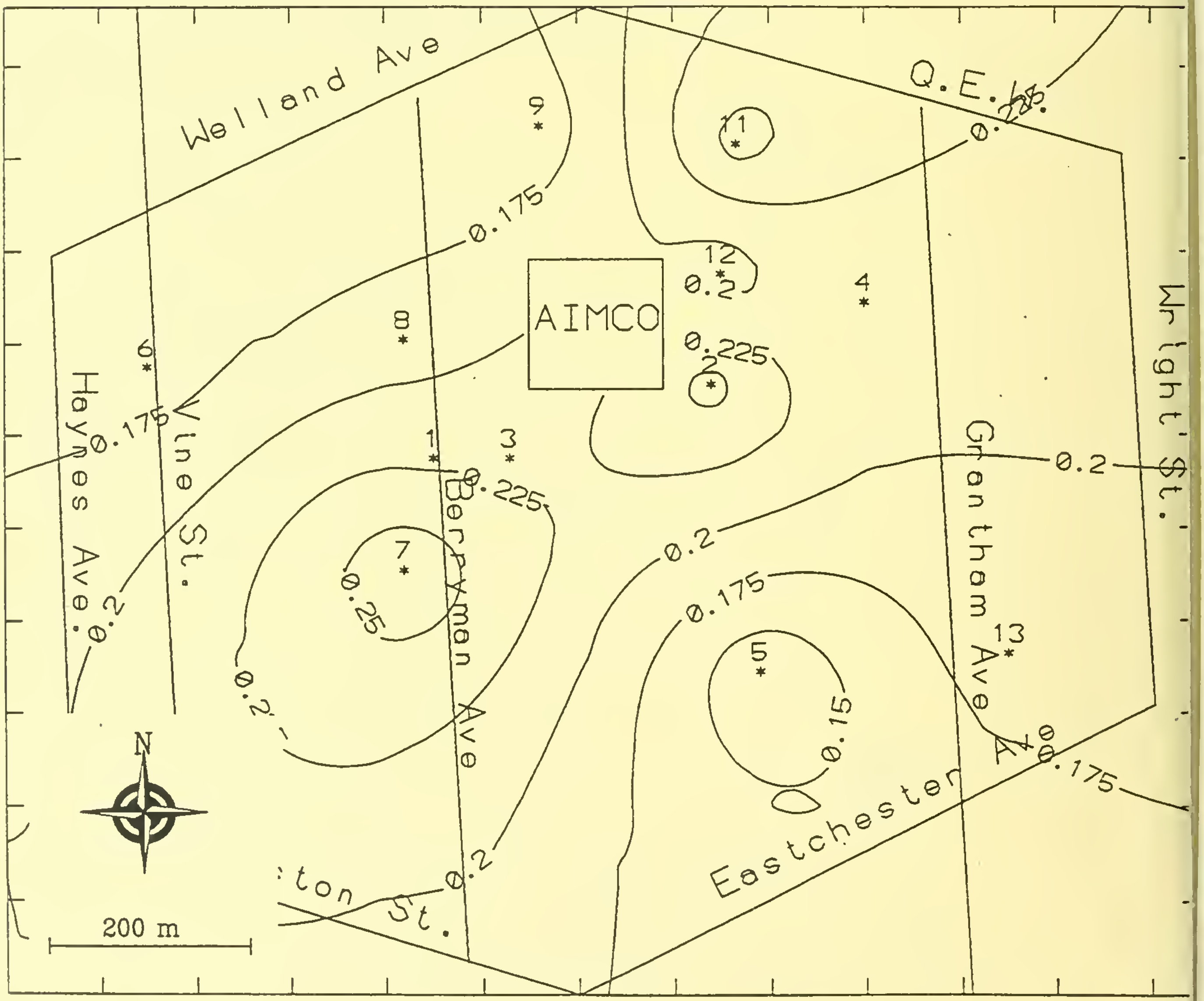


Figure 8: Contour Map of Foliar Sulphur Concentrations (%w/w) in the Vicinity of the Aimco Foundry, St. Catharines, 1991.



Derivation and Significance of the MOEE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOEE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a pollution source. Urban ULN guidelines are based on samples collected from urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (reference: *Ontario Ministry of the Environment. 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples. Phytotoxicology Section, Air Resources Branch: Technical Support Sections NE and NW Regions, Report No. ARB-138-88-Phyto. ISBN: 0-7729-5143-8.*). Chemical analyses were conducted by the MOEE Laboratory Services Branch.

The ULN is the arithmetic mean plus three standard deviations of the suitable background data for each chemical element and parameter. This represents 99% of the sample population. This means that for every 100 samples that have not been exposed to a pollution source, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOEE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.